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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003902831 for a patent by BEN BREMAUER as filed on 06 June 2003.



WITNESS my hand this  
Seventeenth day of June 2004

*J. Billingsley*

JULIE BILLINGSLEY  
TEAM LEADER EXAMINATION  
SUPPORT AND SALES

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ORIGINAL

PROVISIONAL SPECIFICATION

Title: - ELECTROLYTIC SANITISER GENERATOR

Applicant: BEN BREMAUER

The invention is described in the following statement:

## ELECTROLYTIC SANITISER GENERATOR

### Field of Invention

This invention relates to an electrolytic sanitiser generator.

### Background Art

5 The following description of the prior art is not intended to be, nor should it be interpreted as, an indication of the common general knowledge pertaining to the invention, but rather to assist the person skilled in the art in understanding the developmental process which led to the invention.

Methods of electrolytic chlorination for the purpose of sanitising water, in particular, 10 swimming pool and spa water have been disclosed. However, this invention is also applicable to other water sanitizing processes, such as involving water towers for air conditioning, and particularly any other application that requires the addition of a halogen sanitizer, such as chlorine, chlorine dioxide or bromine.

An electrolytic chlorine generator may involve the supply of low voltage DC power to 15 an electrolytic cell. Chlorine (or chlorine dioxide) is generated in solution with the relevant salts dissolved in water. The water containing the solute may be passed through the cell for the purpose of sanitizing a body of water, such as a pool, spa or water tower.

It has been disclosed that by adding a specific amount of sodium chloride to the body of water and providing an electrolytic cell powered by a low voltage DC source in a filtration 20 system, chlorine gas may be produced in the cell and dissolved into the feed water. This process can be used to effectively sanitize and treat the body of water. Although an adverse byproduct of this process is the production of hydrogen gas  $H_2(g)$ , under normal operating conditions the hydrogen gas flows with the feed water into the body of water and escapes safely into the atmosphere.

25 However, in some circumstances the water flow conditions may not be normal and it is at these times that safety issues arise with respect to hydrogen gas containment. For example, a blocked suction line, closed valve(s), incorrect installation or a seized pump can effect a loss of water flow. It may also cause present safety devices to become ineffective, inoperable and/or redundant. In such circumstances, the cell may continue to produce 30 hydrogen gas such that the volume of hydrogen gas contained in the system may reach dangerously explosive levels. The hydrogen gas may continue to be produced and fill not

water in the electrode chamber which triggers cessation of production of hydrogen gas. This effectively limits the maximum production of gas to the volume of the chamber which is less than 2L. The design of the apparatus is such that even if the valve/s on the return or discharge side of the chlorinator are accidentally closed, the gas will still displace all the water in the cell and contain the gas in the cell chamber. If both the suction line valves and the return line valves are accidentally closed such that a net water flow in any direction is not possible, the flow switch activates and ceases power delivery to the electrode bundle.

The apparatus may operate without a flow rate control valve or check valve. The apparatus may be adapted to vary the power to , or the activity of the electrolytic cell whereby to regulate the rate of electrolysis.

The bi-directional water flow by-pass may be included within the internal lower body manifold assembly. This integral by-pass assembly which is located within the lower cell body manifold serves two purposes:

- (1) To deliver a predetermined water flow through the electrode chamber whilst allowing excess water flow to by-pass the electrode chamber; and
- (2) To prevent undesirable back pressure in systems where the flow rate must remain high.

The by-pass may simply be an opening or series of openings by which water travels from within the internal by-pass chamber and out into the cell discharge line without travelling through the electrode bundle chamber. Preferably, the by-pass contains an opening or series of openings which are only partially blocked by a tension loaded valve which opens at a pre-determined flow rate. The by-pass valve may be a tension loaded valve. The by-pass valve may be a check valve as discussed later. Whilst not totally preventing a by-pass of water, the tension loaded valve may allow for greater control over the by-pass flow.

Preferably, however, the by-pass allows for variable flow through the electrolytic cell and the activity of the cell is regulated by the microprocessor in response to variations in flow rate and other factors, such as salinity and water body selection (e.g. the spa or pool).

The by-pass valve preferably does not operate as a positively closing check valve. A standard check valve allows water to pass in only one direction. If a standard check valve was utilised and reliance was placed purely on the physical design of the inventive cell, a

only the cell chamber but all the filtration system plumbing and receptacles. A large hydrogen gas reservoir may result leading to a potentially explosive condition.

Electrolytic cells have been disclosed in which the electrodes are positioned in between inlet and discharge ports of the cell with no provision to trap and contain hydrogen gas in the event of a water flow stoppage. These cells are plumbed horizontally or vertically and may use flow switches plumbed in series with the cell to detect a water flow fault condition. In such an arrangement, the flow switch may be designed to suspend power to the cell to overcome the potential a hydrogen gas build up.

The use of a flow switch may be considered a good primary safeguard against a loss of water flow. However, the use of a flow switch alone as a single safe guard against hydrogen gas build up has been found, in the inventor's experience, to be insufficient. A flow switch is a mechanical device and therefore has a potential for failure. In the event of a water flow stoppage, a flow switch failure could cause a massive hydrogen gas volume to accumulate in the plumbing and filtration equipment and therefore become hazardous. To the inventor's knowledge and belief, this one safety device, which should only be used as a primary measure, is the only safety feature relied upon by electrolytic chlorinators currently on the market.

US Patent No. 6096202 (Fulmer) describes the use of a looped plumbing arrangement with a spring check valve 22 plumbed in the bypass leg 20 to control flow rate through the piping section 18 to cell 42 and to position a flow switch at the top of the manifold as a safety device. This arrangement does not prevent a build up of hydrogen gas in the event that water flow ceases, the flow switch fails and the plumbing return valve(s) are closed. In circumstances of such failure, hydrogen gas is unable to displace the water in the cell 42 or live leg of the manifold 18. The cell leg or live leg of the manifold will remain full of water. The cell 42 will continue to produce hydrogen gas and there is the potential for all of the plumbing and receptacles to be filled with hydrogen gas as it displaces the water and travels down the dead leg of the manifold. The other vertical leg or deadleg is open to the atmosphere and thus the gas produced in the live leg will form and displace water out of the dead leg and beyond.

There is a real possibility and it does happen from time to time, particularly where owners self-install, that the cell manifold as described in Fulmer is installed accidentally

incorrectly in reverse so that water flows in the incorrect direction. Where the water flow ceases, the flow switch fails and the suction line valve/s are closed or a suction line blockage occurs, a dangerous volume of hydrogen gas will build up as described above. Again the H<sub>2</sub>(g) is unable to displace the water from the cell 42 or live leg of the manifold 5 18 and continues to fill the plumbing and receptacles with hydrogen gas. Similarly, if the manifold 18 is plumbed at more than 90 degrees from the vertical, the limited gas trap that the Fulmer arrangement provides for is ineffective and insufficient in the event of a flow switch failure. The loop in this instance provides a reservoir of water for the cell 42 to produce hydrogen gas and this may continue until a dangerous volume of hydrogen gas fills 10 the system. No provision has been made in the Fulmer system to overcome the safety issues associated with these events. By positioning the check valve 22 in the by-pass leg 20, safety issues are created as Fulmer does not allow the hydrogen gas to displace the water in both of the manifold legs 18 when the failure situations as described above occur.

Fulmer does provide an improvement over electrolytic cell arrangements that do not 15 contain physical gas containment loops of any kind. However, incorrect installation and operational mistakes do indeed occur in the field which lead to dangerous situations developing with potentially disastrous consequences. The inventor has been in the pool industry for more than 20 years in Australia and has witnessed first hand that incorrect installation of these devices occurs frequently.

20 Cells have been disclosed having separate flow switches or integral flow switches which operate at 90 degrees to the direction of flow. A cell may be installed without plumbing the cell in a gas loop and where the cell is at the uppermost portion of the loop. In such an installation, an integral flow switch or a separate flow switch may be installed. In such an installation, the failure of the flow switch to detect a water flow failure could 25 lead to a hydrogen gas build up.

Other manufacturers have used a non mechanical conductive electrode positioned at the top of a horizontal cell chamber. US Patent No. 4861451 (Lennie) describes a cell chamber with inlet and outlet ports positioned at 90 degrees to the lower portion of the horizontal axis of the cell chamber and pointing vertically downwards. In the event that there is a 30 water blockage or the suction and/or discharge valves are closed, the physical design provides the necessary water by-pass or gas loop such that the hydrogen gas produced can

displace the water in the cell and contain the gas to a maximum volume of approximately two litres (2L). This is true even in the event that the conductive water sensor fails. When the cell chamber is full of water, the conductive sensor positioned near the top of the cell chamber conducts across to the electrode bundle within the chamber and the electrical circuit delivers power to the cell. However, because this method of Lennie detects the presence of water only and not the flow of water, it may fail to detect a lack of flow of water if the cell is not installed in the horizontal position as specified in the installation instructions.

Incorrect installation may find the Lennie sensor positioned at the lower portion of the cell rendering it effectively redundant. Incorrect orientation of the cell chamber may cause the inherent physical gas loop to no longer contain hydrogen gas in the event of a flow fault.

If both return and suction line valves are closed, the Lennie chlorinator cell will continue to operate until the gas has displaced the necessary water volume in the cell to switch off the power to the cell. The inability of the hydrogen gas to displace the water in the cell may lead to a pressure increase in the plumbing system and eventually damage the plumbing and potentially cause injury.

Chlorine generators vary greatly in design both with regard to the operation of the power supply and cell design. Where a single polarity direct current (DC) voltage is applied to the cell electrodes, regular acid washing to dissolve the calcium deposit from the electrodes may be required. Where a DC voltage is applied to the electrode bundle and periodically reversed, the calcium scale deposit may be dissolved to effectively prevent calcium scale build up.

Reversing the polarity onto the electrode bundle to effectively keep the electrodes free of calcium scale has been disclosed. One electrode bundle design previously described involves two electrodes on opposing ends of the plurality of solid plate electrodes have opposing polarity's. When a sufficient DC voltage is applied to the two electrodes and sufficiently saline water is passed through to permit electrolysis, an opposing charge is induced onto the plate surface which is parallel and in closest proximity. The other surface of this same plate attains the opposing polarity and will induce an opposing charge onto the next opposing plate surface and so on.

The electrode bundle effectively conducts the current through the plurality of electrode plates and the reaction to produce chlorine gas on the anode faces of the plates occurs. This electrode bundle design described is a bi-polar design and is used because it is compact. A bi-polar cell may operate as a single polarity system where acid washing is periodically required or when a specialised electrode coating is used. Thus the polarity may be periodically reversed to achieve the self cleaning affect.

The efficiency of this process is compromised in three major ways.

If the electrode bundle is poorly designed with insufficient physical barriers positioned onto the electrode bundle, the current leakage may be excessive and this compromises efficiency.

If the power supply is poorly designed and the DC voltage applied across the bundle is too low, the efficiency is reduced. Efficient cell designs have been disclosed, but their inability to operate at excessive salt levels without compromise to efficiency and electrode life mean that there is a need for a device which overcomes these difficulties.

Manufacturer's salinity requirements vary. However, the inventor is of the view that the recommended salinity level should always enable the chlorinator to produce the stated maximum chlorine output. Over salting of the body of water such as pool or spa water is, however, a common problem. Where the salinity level in, for example, a pool or spa is up to 85% greater than that recommended, the chlorine production efficiency and electrode life may decline.

If the salt level is higher than that required to operate the cell at 100% of the manufacturer's stated output, the increased cell load may cause the power supply to limit the current and, in effect, reduce the voltage delivered to the electrode bundle. This may cause the power supply to deliver a voltage of less than 4.0 volts per cell. This will cause the cell to produce chlorine inefficiently, fail to clean itself effectively upon polarity reversal and cause excessive current leakage, thus reducing the life time of the electrode bundle.

It is an object of the present invention to ameliorate or overcome one or more of the disadvantages of the prior art or at least provide a useful alternative thereto.

#### Statement of Invention

Accordingly, the invention provides an electrically powered apparatus for generating a solute to sanitize a body of water, the apparatus including an electrolytic cell having a



proscribed range of operational orientation outside which it is undesirable for the electrolytic cell to operate; and a tilt switch mechanism associated with the electrolytic cell, wherein the tilt switch is adapted to switch off power to the electrolytic cell when said electrolytic cell is orientated outside the range.

5 In another aspect, there is provided an apparatus for generating a solute to sanitize a body of water, a by-product of such generation being an explosive gas, the apparatus including an electrolytic cell having a proscribed range of operational orientation outside which it is undesirable for the electrolytic cell to operate; and a water inlet and outlet both located at the lower end of said an electrolytic cell; wherein the range is the upright  
10 orientation of the electrolytic cell within 45 degrees to the vertical such that, in use, in the event that water flow through the apparatus ceases, the explosive gas will displace water in the apparatus until there is no water in the electrolytic cell, whereby electrolysis and explosive gas production ceases.

In still another aspect, there is provided a method of installing an apparatus as described  
15 above wherein the body of water is serviced by a filter and associated pump, the method including plumbing said apparatus in line and downstream of the pump and filter and orienting said apparatus as close to vertical as possible.

In a particularly preferred arrangement, the apparatus includes an electrolytic cell which is plumbed into a swimming pool or spa filtration system, downstream of all the other  
20 receptacles such as a filter or pump. The apparatus may include:

a lower body chamber comprising a pool or spa water inlet and a chlorinated pool or spa water discharge;

an inner lower body water chamber to direct water flow through an upright electrode bundle column;

25 a bi-directional water flow by-pass valve contained within the lower body chamber;  
an integral non mechanical bi-directional water by-pass port;  
a bi-polar electrode bundle contained within the upright electrode column;  
an upright cell chamber;

a cell chamber end cap which seals the top of the upright cell chamber and contains the  
30 electrical termination points for one or more of the following: the electrode bundle, a flow switch, a vertical cell level switch and one or more salinity/water sensors;

a locking ring to compress the end cap onto the cell chamber using an o-ring 25 to form the water seal;

a stainless steel wire gauze to prevent debris from entering the electrode bundle and further prevent current leakage;

5 a lock nut to sealably join the upright cell chamber to the lower body; and/or a pressure relief valve.

The apparatus includes a power supply, which might be mains AC, but preferably includes a low voltage DC power supply. This may deliver a variable power On/Off duty cycle to the cell based on feed back information a computer processor such as a 10 microprocessor associated with the power supply receives from the electrode bundle. Such information may include salinity levels, water flow rate, water presence and/or current draw.

The low voltage DC power supply may contain a transformer, rectification device and a controlling microprocessor based printed circuit board (PCB) which controls the DC power 15 modulation to the cell. The apparatus is adapted to restrict the build up of hydrogen gas to less than 2 litres (L) through aspects of the physical design and electronic safeguard of the apparatus. An installation method may include installing the cell of the invention downstream of all the other receptacles such as filtration devices.

The cell may contain a vertically operated flow switch, an omni directional cell level 20 switch, conductivity sensors, an integral bi-directional water by-pass and/or a pressure relief valve. All these may combine with the vertical physical design of the cell to minimise the hydrogen gas hazard and maximise safety. Even if the cell is installed incorrectly, back to front, upside down or the fault conditions as previously described in relation to the prior art exist, the inventive device described herein best ensures that the safety aspects of the device 25 are not compromised. A 2L volume of hydrogen gas is considered safe in the water treatment industry.

The cell may be an electrolytic halide generating cell which contains an integrated bi-directional water by-pass valve, a water flow switch, a salinity/water sensor, a pressure relief valve and an omni directional tilt switch for the purposes of delivering a halide 30 sanitizer to a body of water in a safer manner than is presently available.

The apparatus may include an chlorinator power supply that uses current draw information derived from the cell electrodes to modulate and control power delivery to the cell. This current feed back modulation may fully optimise cell efficiency and durability even if the salinity is higher than ideal.

5 The apparatus may dramatically minimise the horizontal plumbing space required to accommodate an electrolytic cell. The improved safety implications of this will become apparent to the skilled person from this description.

The apparatus may also include a pressure relief valve within a lower body of the cell. The valve may be designed and located such that if the inlet and discharge ports of the cell  
10 are closed and all of the electronic protection devices fail and the chlorinator continues to produce hydrogen gas, the pressure relief valve may be adapted to open at 150 kpa to 350 kpa, and preferably 200 kpa to 250 kpa. The relief valve will effectively allow the increased pressure in the cell to force out the water contained and resting in the lower body of the cell. Once the hydrogen gas has displaced the water in the cell, the water will be below the  
15 electrode bundle which will be unable to further produce hydrogen gas.

Using a power supply with a larger amperage capacity will allow the cell to draw a larger current under excess salt conditions which prevents premature current limiting devices to reduce the voltage to the cell which causes the inefficiencies. This excess current draw by the electrode will however compromise the life time of the electrode and deliver  
20 more chlorine per hour than officially stated.

In answer to the disadvantages of the aforementioned prior art in relation to excessively saline water, the present invention may be able to maintain the correct cell voltage even if the salinity level is up to 85% greater than that which is recommended and required to operate the cell at the predetermined chlorine output maximum. Under the present  
25 invention, electrode life may not be compromised as would be the case where an oversized power supply with excessive current capacity is inappropriately utilised and the electrode operating time is not reduced.

The apparatus may include a microprocessor to process current draw information obtained from the electrode bundle. The current draw information may be directly related  
30 to the salt level in the water. If the current draw exceeds a predetermined maximum required for the cell to produce a published chlorine maximum, an On/Off duty cycle of the

power delivery to the cell is altered so that the total chlorine production per hour is moderated to correspond to the desired chlorine production rate.

Where the cell is intended to be installed in a vertical orientation, but is incorrectly installed at an angle of up to 45 degrees from the vertical, based purely on the physical aspects of the cell, the containment of hydrogen gas is limited to the volume of the cell chamber which is preferably less than 2.0L. It is considered that this is a safe gas volume. The inventive arrangement may therefore allow for a large degree of orientation error. However, if the incorrect orientation of the cell exceeds an angle of 45 degrees from the vertical, the physical design alone of the inventive arrangement may not contain the hydrogen gas to the chamber and may allow the hydrogen gas to escape and fill the plumbing and receptacles in the system. This may result in the accumulation of a dangerous reservoir of hydrogen gas.

Advantageously, a tilt switch mechanism may be provided on the cell for the purpose of limiting the potential development of a dangerous volume of hydrogen gas in the event that the chlorinator cell is not installed vertically or in the recommended plane for the particular application. The switch may suspend power delivery to the cell and cause the electrolytic reaction that produces the hydrogen gas by-product to cease in the event that the cell is not installed in the correct orientation as per installation instructions.

The tilt switch therefore further obviates these hydrogen gas safety concerns associated with incorrect cell installation and or damaged or sagging plumbing. If the vertical cell chamber deviates from the vertical by a predetermined value over 45 degrees, the tilt switch will activate causing the circuit to cut power delivery to the cell. This ensures that hydrogen gas is not produced.

A tilt switch could be adapted to all cell housing designs to improve the safety aspect of existing cell installations. The physical aspects of the upright cell of the invention, however, provide the first safety feature. This tilt switch safety mechanism augments the physical safety feature thus further lessening the likelihood that an excessive and dangerous hydrogen gas build up does not occur.

The apparatus may include a water by-pass within the lower body of the cell chamber. The by-pass may be bi-directional. In the event that water flow ceases and the incorporated vertical flow switch fails, the cell continue to generate hydrogen gas until it displaces the

has inherent safety implications.

Salt chlorinator installation instructions, independent of the design, should always insist that the cell installation be downstream of all of the other filtration system receptacles. This ensures concentrated chlorine produced does not corrode heaters, for example. It also helps to eliminate the possibility of a dangerous volume of hydrogen gas accumulating in the filter bowl or the solar heating system or any other receptacle where accumulation of in excess of 2.0L of gas may occur.

Yet another preferred feature of the inventive chlorinator cell is the substantially vertical or upright arrangement of the electrode bundle. The electrode bundle may be any suitable configuration and may comprise multiple plates or other terminal features. The bundle may be square or circular, oval or rectangular upright in cross-section. The bundle may be squat shaped or elongate. Preferably the bundle comprises between seven and nineteen plates. Where there is a lower number of plates, the bundle may include a centrally located insulator. The insulator may act as a flow regulator to offer resistance to water flow which would otherwise be present with larger numbers of plates to ensure sufficient time exposure to the bundle. The electrolytic cell may include an inner bi-polar electrode bundle. The bundle may be situated centrally within the cell chamber. The cell chamber may be any suitable configuration. It may be compact or elongate. It may be cylindrical, oval, square or rectangular in cross section. Preferably the cell chamber has an elongate cylindrical shape.

Water may be directed upwards by the by-pass assembly through the electrode bundle chamber. After exiting the electrode chamber, the water is redirected 180 degrees in a U-turn and flows vertically downwards through an internal, preferably circumferential or annular, space between the electrode bundle chamber wall and an outer cell chamber. If the outer cell chamber is clear, the evidence of water flow or electrolysis occurring will be very easy to visually establish by the operator where the outer cell chamber wall is transparent.

The electrode chamber may be connected to an end cap which may be removable for replacement or service of the internal components of the cell. The inventive design allows the cell to be very compact whilst addressing the hydrogen gas containment issues.

Another safety feature is that the direction of flow through the cell electrode chamber could be reversed without jeopardising the safety of the arrangement as a result of incorrect installation.

The inventive cell may include a pressure relief valve in the lower body chamber. In the event that both the inlet port and the exit port are closed, and the electronic protection devices fail to detect the absence of water flow and fail to suspend power to the cell, the pressure relief valve will open to allow the hydrogen gas to displace the water from the cell chamber which will effectively cause a cessation of electrolysis.

It is the inventor's 20 years experience in this field that has shown that instructions are not always followed by the installer if adhering to them requires more time and effort. It is a re-occurring theme that installers of these devices find the large space required by some of the presently available chlorinator cells particularly difficult to fit, especially in retro-fit applications. If the installer does not fully appreciate the implications of installing the cell upstream of all the other filtration equipment receptacles, he may install it upstream if the plumbing more easily allows for it. Because the cell disclosed herein uses only 190 mm of plumbing space, the likely hood of finding a satisfactory area downstream of the other receptacles is greater.

15 There is no practical way of ensuring that the cell is installed in the correct downstream position of the plumbing system thus preventing the possibility of a hydrogen gas accumulation in the equipment receptacles. The preferred cell arrangement, however, has inherent physical design and electronic features to safely control the hydrogen gas production if the cell is not installed vertically or a flow fail condition occurs. These 20 features are not negated if the cell is installed upstream of the other equipment receptacles in the system and the likelihood of a hydrogen gas accumulation occurring in one or more of the other receptacles is greatly reduced.

#### Brief Description of the Drawings

The invention may therefore be better understood from the following non-limiting 25 description of possible and preferred features of one or more of the preferred embodiments of the invention. It is to be understood that the features illustrated in and described with reference to the drawings are not to be construed as limiting on the scope of the invention. In the drawings:

Figure 1 is a perspective view of an electrolytic cell according to one embodiment;

30 Figure 2 is a transverse section of the electrolytic cell shown in Fig. 1; and

Figure 3 is a transverse section of the electrolytic cell shown in Fig. 1 rotated 90 degrees relative to the view shown in Fig. 2.

Detailed Description of the Drawings

In the drawings there is shown an apparatus including an electrolytic cell 1. The apparatus forms part of a swimming pool or spa filtration system. The apparatus is plumbed downstream of all other receptacles in the system, the apparatus including:

- a vertical cell chamber 18;
- a lower body 12 depending from the vertical cell chamber 18, the lower body 12 comprising a pool or spa water inlet port 13 and a chlorinated pool or spa water discharge or outlet port 14;
- an inner lower body water chamber 15 to direct water flow through opening 4 to a vertical electrode bundle column 16 containing a bi-polar electrode bundle 28;
- a bi-directional water flow by-pass valve 17 associated with the lower body chamber 15;
- 15 a non mechanical bi-directional water by-pass valve port 21 integral with {Ben, please clarify: the bi-directional water flow by-pass valve 17 OR the lower body chamber 15};
- a cell chamber end cap 26 to seal the top of the vertical chamber 18 and to contain the electrical terminals 2,3 for the electrode bundle 28, flow switch 20, vertical cell level switch 22 and salinity/water sensors 23;
- 20 a locking ring 24 to compress the end cap 26 onto the cell chamber 18 using an o-ring 25 to form a water- and gas-tight seal;
- a stainless steel wire gauze 27 to prevent debris from entering the electrode bundle 28 and to further prevent current leakage;
- a lock nut 29 to sealably secure the vertical cell chamber 18 to the lower body 12; and
- 25 a pressure relief valve 31.

The system also includes a low voltage DC power supply (not shown) which delivers a variable power On/Off duty cycle to the cell 1 based on feed back information a microprocessor associated with the power supply receives from the electrode bundle 28.

The low voltage DC power supply contains a transformer, rectification device and a controlling microprocessor based PCB which controls the DC power modulation to the cell 1. The present invention may be adapted to restrict the build up of hydrogen gas to less than

2 litres (L) in the system through aspects of the physical design and electronic safeguards. An installation method may include installing the cell 1 downstream of all the other filtration receptacles.

The cell 1 is preferably installed such that the lower body 12 is placed in the plumbing 5 line with the inlet port 13 and the outlet port 14 horizontally positioned. Both are ports 13,14 are preferably clearly marked to avoid incorrect directional installation, but if the cell 1 is installed back to front so that the inlet port 13 is connected to an outgoing pipe, none of the safety aspects of the apparatus will be compromised.

Located within the lower body 12 is the inner lower body water chamber 15. This 10 chamber 15 directs a proportion of the incoming horizontal water flow upwards in a vertical direction through the electrode bundle column 16 where in operation electrolysis occurs.

The chamber 15 also contains the integrated bi-directional water by-pass valve 17. This spring assembly 17 is preferably preset to permit a predetermined proportion or certain flow rate of water to by-pass the cell 1 and the electrode bundle column 16. This effectively 15 reduces the pressure drop across the cell assembly which is desirable in high flow applications.

The bi-directional water by-pass valve 17 can not totally restrict the by-pass of water and force all of the water flow through the electrode bundle column 16. The by-pass valve 17 is designed such that it only blocks a percentage of the by-pass valve port 21. The inner 20 lower body chamber 15 therefore allows the water to flow from the inlet port 13 to the outlet port 14 or vice versa. This feature allows hydrogen gas generated by the electrolytic reaction to displace the water in the cell 1 and to contain the hydrogen gas within the cell column 16 in a safe volume in the event that the primary electronic flow switch 20 fails to operate. The flow of water across the opening 4 in this by-pass assembly must allow 25 enough water to flow through the body chamber 15 in both directions such that it is at least equivalent to the maximum rate at which the hydrogen gas displaces the water in the cell chamber 18.

The electrode bundle column 16 is located within the vertical cell chamber 18. The electrolysed water that passes through the column 16 is forced 180 degrees to a vertically 30 downward direction in the annular space 5 between the column 16 and the chamber 18. During electrolysis, the operator will be able to see the gaseous products of the reaction as



the electrolysed water flows down through the annular space 5 and out through the discharge port 6 of the chamber 18.

Positioned at the very top of the cell is the cell chamber cap 26 which contains the electrical terminals 2,3 for the electrode bundle 28, the flow switch 20, the omni directional 5 cell level switch 22 and the salinity/water sensors 23. The locking ring 24 holds the cap onto the top of the vertical cell chamber 18 and seals same by way of an o-ring 25.

The integral flow switch 20 is positioned directly above the water exit area 7 of the electrode bundle column 16. The flow switch 20 can be adjusted to switch on and activate the cell 1 at a specified flow rate. The flow switch 20 includes a doughnut-shaped magnet 10 which moves upward along a hollow plastic shaft if sufficient water flows through the water exit area 7 to displace the magnet from a resting position and activate the flow switch 20. The hollow shaft contains a reed switch which recognises the position of the magnet. If the magnet is uppermost (i.e. corresponding to a high flow rate), the switch will close a circuit and the power supply will deliver power to the electrode bundle 28 to effect electrolysis of 15 the water borne electrolyte.

The apparatus includes the vertical cell level switch 22 which is capable of operating in any orientation such that it may be described as omni-directional. This tilt or tip over switch 22 is wired and fitted into the cell chamber cap 26 such that if the cell chamber 18 is not vertically upright when plumbed, the tilt switch 22, which will have a predetermined 20 electrical contact break at a specific angle of less than 45 degrees from the vertical, will activate to cut power to the cell 1. This safety feature overcomes the problem of the incorrect installation of salt chlorinator cells which does occur and this often compromises the effectiveness of the safety features of other electrolytic cells available.

The salinity/water sensors 23 are positioned in the upper portion of the space 5 of the 25 vertical cell chamber 18. The salinity/water sensors 23 include two sensor electrodes. The two electrodes test the salinity level periodically. The information is cross-referenced with the current passing through and the voltage of the electrode bundle 28. This information is processed by the microprocessor in the power supply and the determination of both the salt level and the electrode condition are made and displayed on a display for the benefit of an 30 operator. Process calculations are made according to suitable algorithms to determine the amount of salt to be added and this may also be displayed if information about pool volume

is programmed in by, for example, the operator. The salt level sensors 23 also act as another electronic flow-fail safety device. If the sensors 23 detect the absence of water, the power to the electrode bundle 28 will be cut and a flow fail indication will be displayed.

The power supply includes a feature which maximises the efficiency and lifetime of a typical bi-polar cell. The cell bundle 28 shown in the preferred embodiment has thirteen electrode plates all spaced at approximately 2 mm apart and positioned parallel to one another. The two outer plates and the middle plate are connected to the low voltage DC power source. Preferably, 28 VDC is used which in effect delivers 4.7 VDC maximum per cell. However the person skilled in the art will appreciate that there are many variations on this arrangement whereby the number of plates and the amount of DC voltage may be varied depending on the application, cost and space constraints.

Manufacturers of pools or spas typically give installers advice as to what is the preferred salinity level of the pool or spa water. For various reasons, pool or spa water often has a resultant salinity higher than that which is recommended. As a salinity overload safety feature, many chlorinator power supplies are current limited. This limits the current draw of the cell and protects the power supply. A typical chlorinator power supply has electronic circuits that will current limit or, in effect, reduce the DC voltage to the cell in order to control the amp draw of the cell.

The method by which power is supplied to a bi-polar electrode bundle arrangement such as in cell 1 is important in determining chlorine production efficiency, reverse polarity self cleaning efficiency and electrode lifetimes. As a benchmark it is preferable to maintain DC voltage at no less than 4.0 Volts per cell to optimise efficiency and electrode lifetimes.

The delivery of power to the cell may involve the use of a microprocessor in association with the low voltage DC power supply 24. This enables the processing of current draw and voltage information obtained from the electrode bundle 28. The current draw information is directly related to the salinity level or conductivity of the water. If the current draw exceeds the predetermined maximum required for the cell to produce the published chlorine maximum, the power on/off duty cycle will be automatically altered such that the chlorine production rate per hour is maintained as per the stated output. Although the current density may be greater at times when the salinity is higher than required, the automatic duty cycle modulation ensures that in such cases, the power ON portion of the

cycle will be proportionately reduced and the OFF portion increased, ensuring electrode lifetimes are not compromised.

In effect, if the salt level is at the predetermined recommended level or if it is up to 85% in excess, the power delivered to the cell 1 over a 24 hr period will remain constant as will the chlorine output. Excess salt levels over and above 85% of the recommended concentration will cause inefficiencies in the cell 1 to develop. An excess of salt to this degree would be highly unlikely. If, however, this does occur, analysis by the microprocessor would recognise this excess and the diagnostic display on the power supply would recommend dilution of the water and/or the microprocessor would switch off power to the cell 1.

Although the power supply must be designed to handle a higher current than may usually be provided, the increase in VA power of the transformer need not be proportional to the maximum current increase desired. If an excess salt level exists and a higher current is drawn by the cell than is normally required to produce the published chlorine output per hour, the ON portion of the duty cycle is reduced and the OFF portion of the duty cycle is correspondingly increased. Because the duty cycle modulation is based on the current draw information obtained from the cell 1, the power output per hour of the power supply remains constant even if the salinity is up to 85% higher than normally required to achieve the stated maximum chlorine output. The automatic reduction in the ON time portion of the duty cycle if excess salt is present obviates the requirement for the use of a proportionally larger VA transformer than would normally be the case if this automatic duty cycle modulation was not effected.

A electrode bundle 28 may include a seven plate or blade electrode bundle. In this case, a plastic insulator 29 must be inserted alongside and up against the outer face of the exposed seventh electrode and positioned centrally within the thirteen blade electrode column 16. This insulates the outer portion of this seventh plate and restricts the ability for the face of same to take part in the electrolytic reaction. If the face of the seventh plate was exposed, current leakage might increase and cell efficiency may decrease. This plastic insulator must incorporate a water by-pass flow barrier 30 that extends perpendicular to the direction of flow through the electrode chamber.

The area of the perpendicular barrier that affects the flow restriction should approximate the restriction to flow affected as if the remaining six electrodes were in place. In general, the restrictive area would equate to between 2.0 to 10.0 cm<sup>2</sup> and more particularly 5.0 cm<sup>2</sup>. This ensures a consistent water flow through the electrode plates 5 whether there exists a thirteen-plate or seven-plate configuration. The insulation barrier is not needed in the 13-plate configuration when the electrode bundle column itself provides an effective insulation barrier.

The preferred form of the invention may obviate the need to manually test the cell to determine the condition of the cell 1 and can provide for means to incorporate testing means 10 into the apparatus. Salinity is measured within the cell 1 via the sensors 23 and the information is processed and interpreted according to a known relationship of cell current draw verses salinity by the microprocessor. If the cell 1 draws a lower current than that which is anticipated as per the relationship programmed into the microprocessor, an indication that the cell electrode bundle 28 is faulty will be illuminated on the display.

15 Many chlorinators presently on the market determine the salinity of the water via the current draw of the cell only. This method, however, may cause the operator to over salt the pool if the cell is faulty or is at the end of it's life and draws a lower current.

The preferred form of the invention may also obviate the need to manually switch the chlorinator cell 1 off to prevent over-chlorination when the body of water being treated is 20 reduced in volume by a factor of up to 20 times. This typically occurs with a combined pool and spa where the chlorinator cell serves to treat both pool and spa under normal filtration conditions. The body of water associated with the pool and spa combination is normally 50,000L, the spa is typically only 1500L. If the plumbing, for example by the use of valves, isolates the pool from the filter system so that the spa volume alone is being filtered, the 25 chlorinator must switch off or operate at a reduced output. Otherwise over chlorination will result. The preferred embodiment recognises the heating of the spa via a flow switch plumbed into the spa suction line. In a pool and spa combination, generally the only time the spa suction is opened is when the spa is being heated and used. A flow switch in the spa suction line is used to provide feedback to the microprocessor which controls the operation 30 of the chlorinator that the spa heating or use cycle has begun. The flow switch located in the spa suction line is activated so that the microprocessor recognizes this condition and the

power to the cell chlorinator is switched off or reduced to a limited output level. This ensures that the small body of water in the spa will not be over chlorinated.

The chlorinator cell 1 preferably has a flow switch 20 associated with or connected to it. When the flow switch 20 is activated (i.e. low or no water flow through the cell), chlorine production is switched OFF or a reduced output mode is activated. The flow switch 20 is preferably positioned in the cell 1 and may relay information to the master control or microprocessor regarding the flow condition.

Generally when a pool pump (not shown) is starved of water, the water within the pump will heat up and damage the pump. The apparatus can include a pump protection monitor within the chlorinator cell 1 which records the time or duration that the flow through the cell 1 has ceased and, according to a preprogrammed time delay, will switch off both the chlorine cell 1 and the pump. This protects the pump from running dry and damaging itself.

Any auxiliary device/s may also be operated from microprocessor of the chlorinator 1 and may be protected in the same way as the pump as described above.

For example, if the apparatus may include a first and a second time clock. The second time clock within the microprocessor or chlorinator may be used to control a second pump which may be used to regulate the operation of a pressure-type pool cleaner. In this case, a flow sensor 20 located within the cell 1 and positioned on the return line downstream of all of the other equipment in the filtration system, will detect when flow ceases. The pressure pump used to operate the cleaner requires the primary filter pump to be operating correctly to provide water to the pressure pump. If the filter pump is switched off or is being used to backwash the filter, water flow on the return line ceases and the pressure pump will be starved of water thereby damaging it if it is not switched off. This arrangement obviates the need to manually switch the pressure pump off. Via the flow switch 20, the processor switches the pressure pump off during any period in which it detects no flow.

Under prior art regimes, the operator must manually test the salt level by means of a conductivity test apparatus or chemical test. Once the salt level is established, a manual calculation of the salt requirement is performed using a table. This table lists the amount of salt required to raise a volume of water to a specific salinity. In the present arrangement, assuming the correct water body volume has been recorded by input into the

microprocessor, the microprocessor is adapted to indicate to an operator, via the display, how much salt to add to correct any deficiency in the level of water salinity.

The salt sensors 23 within the cell column 16 inform the processor of the level of salinity of the body of water and reference this salinity level to the target salinity which is 5 proscribed by the manufacturer.

The operator/installer must program into the chlorinator 1 the water body (such as pool) volume. The microprocessor is then able to calculate the salt deficiency based on known formulae and to display the recommended salt addition required to correct this deficiency.

Example

10 If the tested salinity is 2000 ppm, the pool volume is 45,000L and the target salinity is 2500 ppm, the chlorinator 1 will display a required salt addition of 22.5 kg to rectify the deficiency.

Throughout the specification, including any claims, the word "comprise" and its derivatives are intended to have an inclusive rather than exclusive meaning unless the 15 context requires otherwise.

It will be appreciated by those skilled in the art that many modifications and variations may be made to the embodiments described herein without departing from the spirit or scope of the invention.

The following statements assist in further describing the invention:

- 20 1. An electrically powered apparatus for generating a solute to sanitise a body of water, said apparatus including:
- a) an electrolytic cell having a proscribed range of operational orientation outside which it is undesirable for said electrolytic cell to operate; and
  - b) a tilt switch mechanism associated with said electrolytic cell,
- 25 wherein said tilt switch is adapted to switch off power to said electrolytic cell when said electrolytic cell is orientated outside said range.
2. An apparatus for generating a solute to sanitise a body of water, a by-product of such generation being an explosive gas, said apparatus including:
- a) an electrolytic cell having a proscribed range of operational orientation outside
- 30 which it is undesirable for said electrolytic cell to operate; and
- b) a water inlet and outlet both located at the lower end of said an electrolytic cell;

wherein said range is the upright orientation of said electrolytic cell within 45 degrees to the vertical such that, in use, in the event that water flow through the apparatus ceases, the explosive gas will displace water in the apparatus until there is no water in said electrolytic cell, whereby electrolysis and explosive gas production ceases.

- 5 3. A method of installing an apparatus according to statement 2 wherein said body of water is serviced by a filter and associated pump, said method including:
  - a) plumbing said apparatus in line and downstream of said pump and filter; and
  - b) orienting said apparatus as close to vertical as possible.
4. An apparatus according to statement 1 or 2, further including:
  - 10 a) a lower chamber incorporating said inlet and said outlet; and
  - b) a bi-directional water flow by-pass for by-passing said electrolytic cell in said lower chamber.
5. An apparatus according to statement 4, wherein said bi-directional water flow by-pass includes a bi-directional check valve.
- 15 6. An apparatus according to statement 1 or 2, wherein said apparatus is adapted to be installed in a plumbing circuit using less than 200 mm of pipe space.
7. An apparatus according to statement 2, further including:
  - c) a cell column housing said electrolytic cell and defining a passage for the in-flow of water from said inlet; and
  - 20 d) an outer chamber housing said column whereby a space is defined between the outer surface of the wall of said column and the inner surface of the wall of said chamber to, in turn, define a return passage for outgoing water leading to said outlet.
8. An apparatus according to statement 4, further including a pressure relief valve in the lower chamber.
- 25 9. An apparatus according to statement 1 or 2, further including a flow switch to detect the absence of water flow through said apparatus, whereby said flow switch is adapted to effect the cutting of power to said apparatus of the water flow reaches an unsustainable low rate.
10. An apparatus according to statement 1 or 2, further including a salinity sensor
  - 30 adapted to communicate data to a microprocessor which, in turn, is adapted to regulate the operation of said electrolytic cell.

11. An apparatus according to statement 10, further including a current draw sensor adapted to communicate data to a microprocessor which, in turn, is adapted to regulate the operation of said electrolytic cell.

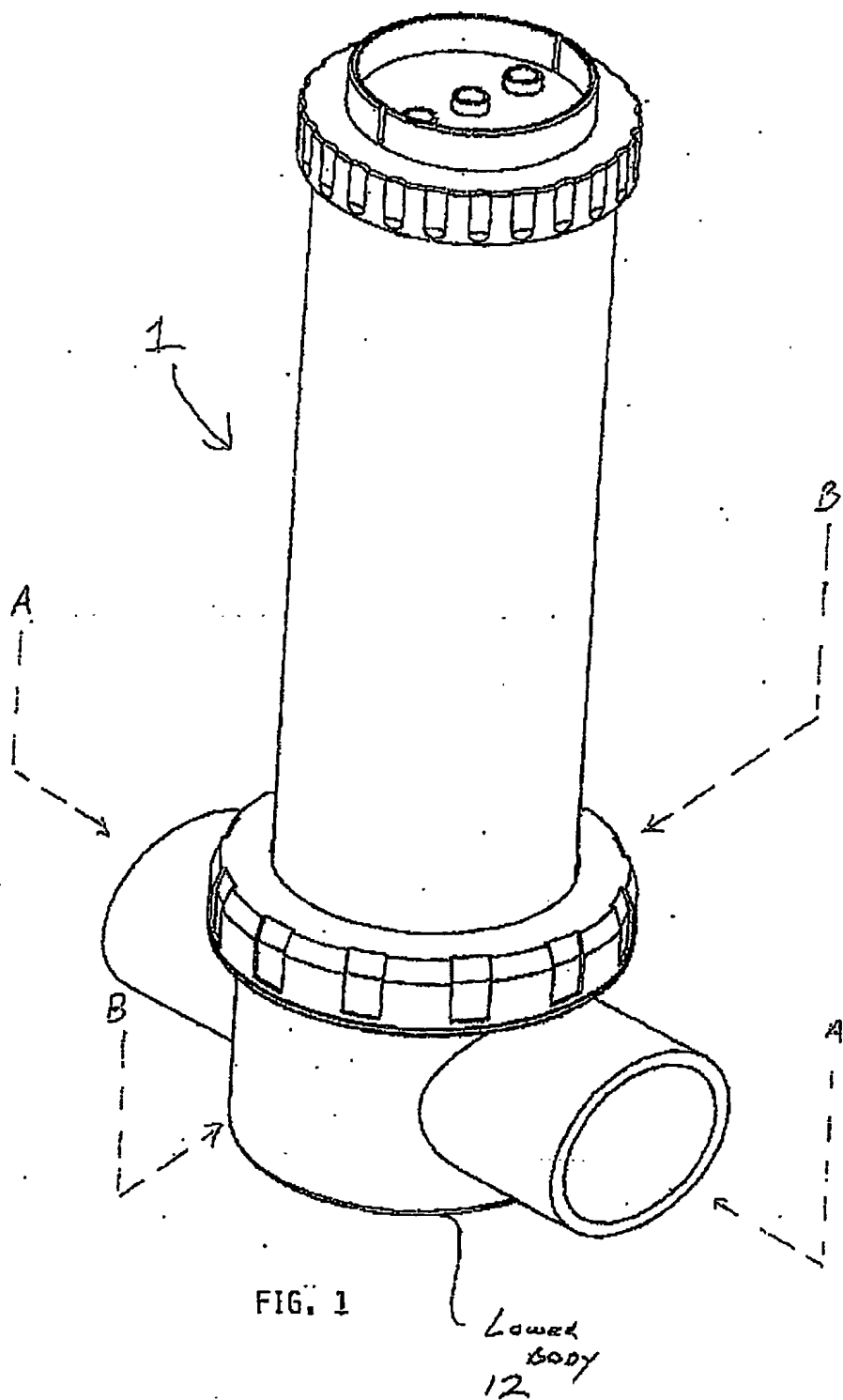
Dated this 6th day of June 2003

S PATENT ATTORNEY SERVICES

Attorneys for

BEN BREMAUER





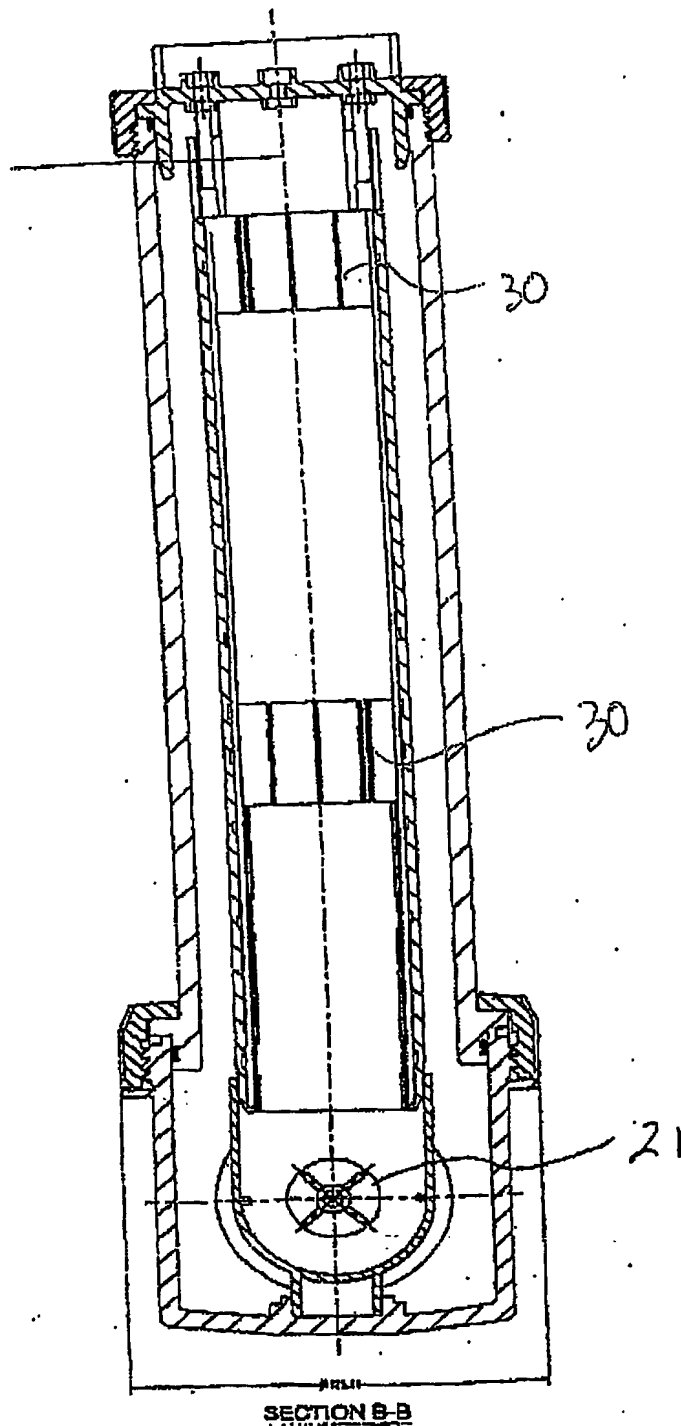
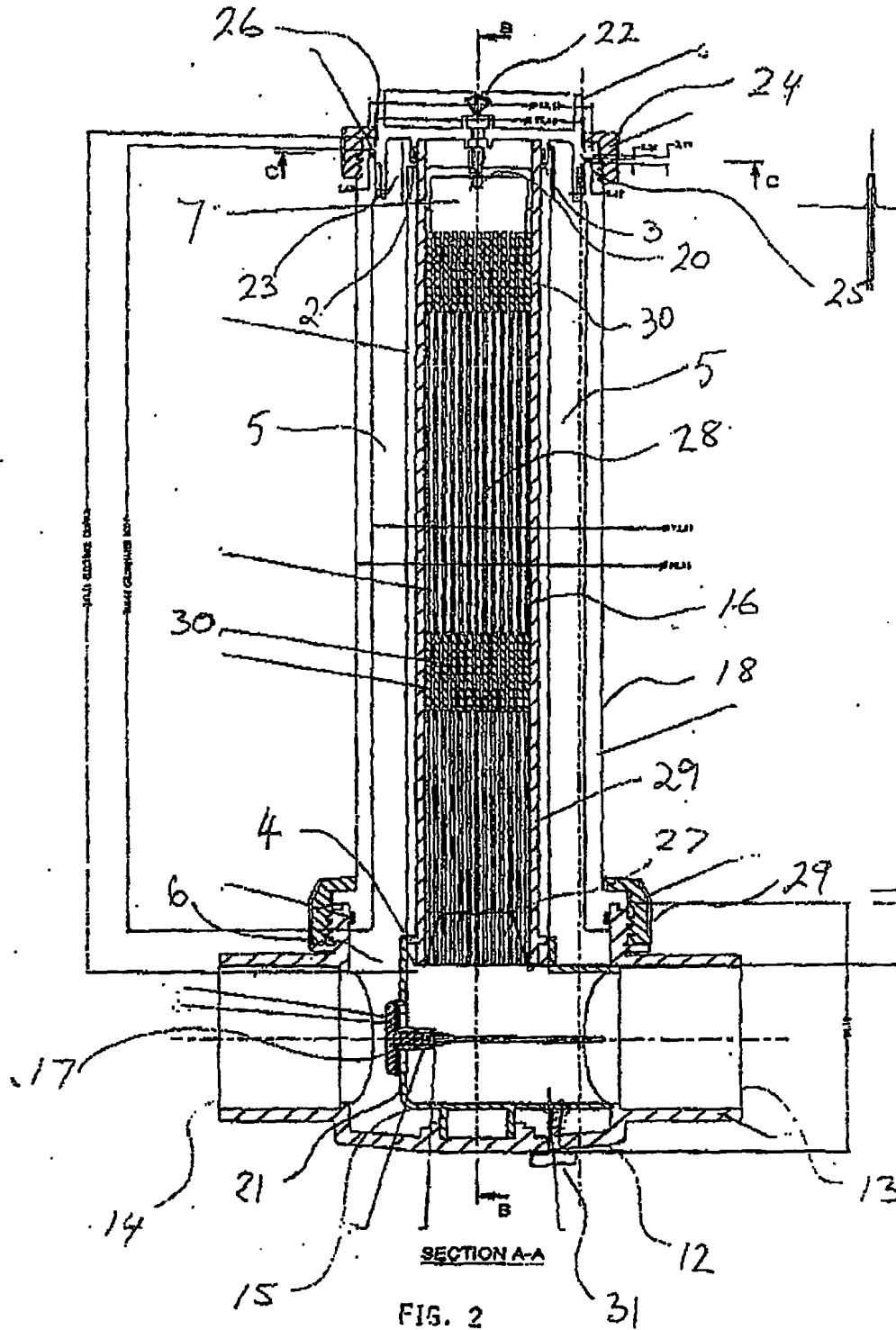


FIG. 3



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